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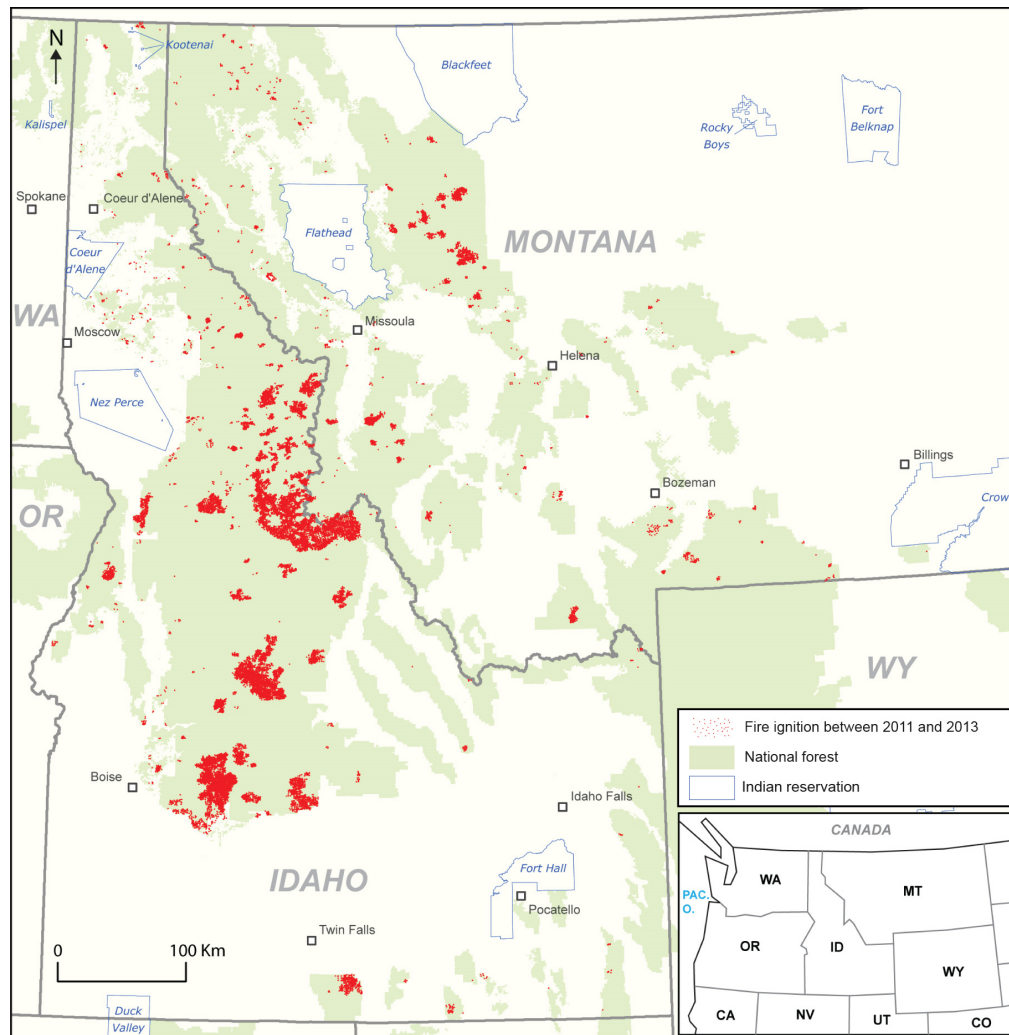
Nicolas Barbier

The controversial management of fire in the national forests of Idaho and western Montana

The case of the montane zone dominated by ponderosa pines and Douglas-firs

Introduction

- 1 Idaho and western Montana are part of the eastern portion of the Inland Northwest. In this region, the montane zone ranges from about 600 meters of elevation to 2,100 meters. It is located just below the subalpine zone (Avian Science Center et Montana Natural History Center, 2005). The humid continental climate of the montane and subalpine zones includes long, cold and snowy winters as well as warm summers. These climate characteristics vary according to elevation and topography. Annual rainfall often fluctuates greatly between higher elevation (abundant precipitation) and lower valleys (semi-arid) (Jackson, 2003; National Climatic Data Center, 2002).
- 2 Ponderosa pine¹ and Douglas-fir² forests are the most widespread in the montane zone of the Rocky Mountains. In these forests, either one of these two species are dominant or the two are co-dominant. A dominant species is the most common within a stand³. In these particular forests, the proportion of other species is lesser (lodgepole pine, western white pine, subalpine fir, western larch, Engelmann spruce, red cedar, aspen, etc.). There are three other forest types in the montane zone of Idaho and western Montana: moist northwestern forests, Northern Rockies mixed-conifer forests and upper-montane mixed-conifer forests (Baker, 2009).
- 3 The U.S. Forest Service (USFS) manages most forests and uninhabited public lands in the study area. Its “mission is to sustain the health, diversity, and productivity of the Nation’s forests and grasslands to meet the needs of present and future generations”. National forests cover 8.2 million hectares in Idaho and 7.8 million in Montana (90 percent of which in its western half). They encompass most lands classified as wilderness areas⁴. Fires (also called wildfires) cover large areas in these wilderness that stretch over 1.6 million hectares in Idaho and 1.4 million in Montana (USFS, 2011) (figure 1).
- 4 In the United States, wildfires have three possible origins. Human-caused fires are the most common (e.g., negligence). Intentional acts of arson come second. Lightning strikes with little or no rain ignite about 10 percent of wildfires in the United States (National Park Service, 2013), but a much greater percentage within the study area (Idaho Department of Lands, 2008).
- 5 This study embraces three topics. First, the past and current characteristics and impacts of fires are examined. As a recent example, between 1997 and 2006 in the Clearwater and Nez Perce national forests (about two million hectares put together in north-central Idaho), fires covered 100,000 hectares, and another 100,000 hectares in 2007 alone (USFS, 2008). Second, the management of two categories of fires is explained: prescribed (controlled by managers) and non-prescribed fires. Finally, the evolutionary and controversial aspects of fire management are analyzed.
- 6 This work is based on research results obtained as a doctoral⁵ and postdoctoral⁶ researcher. Its main purpose is a transfer of knowledge on fire ecology and management. Therefore it is not a theoretical study.
Within this research framework, three main questions need to be answered: In ponderosa pine–Douglas-fir forests of the montane zone, how have fire regimes evolved and contributed to shape these forests? Why and how have fire management and associated methods evolved? To what extent are the objectives and results of the USFS’s management practices consistent with existing scientific opinions?

Figure 1. Fire ignitions in national forests in Idaho and Montana between 2011 and 2013

Sources: Montana State Library, Nez Perce Tribe GIS Departement, Washington State Department of Transportation

Past forests and fire regimes

- 7 “A fire regime describes the nature of fires occurring over an extended period of time (“usually several hundred years or more” [Baker, 2009]) and can be defined in terms of the rotation, return interval, severity, intensity, seasonality, shape, and size typical of fires in a specific geographic area or ecosystem” (Teske et al., 2012)⁷. Vegetation is the most significant determinant of a fire regime. The latter also varies according to the local environment and elevation (Keane et al., 2003). Fire severity is different from fire intensity: severity means the degree of ecological damages caused by fire, whereas intensity is the energy output (in terms of heat) in a burnt area. Fire severity depends on the intensity and duration of fire (Baker, 2009). Long low-intensity fires can be severe and kill a lot of trees, especially if the layer of humus and needles is thick around the trees (Fiedler, 7/22/2011, email).

Synthesis of the existing knowledge on forests and fire regimes before 1900

- 8 Before the conquest of the American West in the Northern Rockies, American Indians used fire to increase their crop yields (e.g., the edible camas roots in Idaho), the density of medicinal plants and forage. In addition, they used it to thin the underbrush, make their seasonal movements easier, clean up their campgrounds, direct the game or entrap groups of enemy warriors. The impact of American Indians on regional forests was generally limited to the vicinity of their villages and corridors of seasonal migration (Vale, 2002). The end of the conquest of the West in the 1890s restricted the American Indian management of fire to Indian reservations.

- 9 Outside these reservations just before 1900, a part of the regional forests had old, wide and high conifers that were more abundant than today. They included ponderosa pines, lodgepole pines, western larches and red cedars among other species. Some were open forests or partially open and were characterized by a relative balance between the different storeys. Old ponderosa pines dominated in quite a few of these forests and withstood low- or even moderate-intensity fires (Arno and Fiedler, 2005).
- 10 The fire regime in most ponderosa pine–Douglas-fir forests was of variable severity (VSR: variable-severity regime: low, moderate and high). The low-severity regime (LSR) could only exist in drier areas where tree density and elevation were in general quite low. Tree density tended to be higher at higher elevations or on moist north-facing slopes where Douglas-fir was commonly the dominant species. After a high-severity fire, relatively young stands (70-100 years old: 450-800 trees/hectare) were not as dense as the youngest stands (1,000- >7000 trees/ha). But they were often denser than old stands (100-400 trees/ha). Old trees with a thick bark and few branches were more resilient to fires than those with a thin bark and numerous low branches (Baker, 7/11/2011, email; Baker, 2009).
- 11 Two scientific hypotheses exist about past fire regimes and their impacts in the study area.

Two different scientific hypotheses on past fire regimes

- 12 This study makes a distinction between the research results of Stephen Arno and Carl Fiedler⁸ on the one hand, and William Baker and his colleagues⁹ on the other hand. These two groups of researchers have developed their own scientific hypothesis. Arno and Fiedler's research lies on fire scars, an inventory of tree stumps and other traces of past regimes. They also use old documents (results of surveys; photographs; written records) (Arno and Fiedler, 2005). Baker and his colleagues work on lands that have not been logged. Their research is based on scientific reports of the late 19th century, growth rings of trees and fire scars (Baker et al., 2007).
- 13 Baker and his colleagues focus on the Northern Rockies (Colorado, Idaho, Montana, Utah et Wyoming for the most part); Arno and Fiedler concentrate on the montane zone within the Pacific Northwest region (Idaho, western Montana, Oregon, Washington). A part of their respective study areas cover Idaho and western Montana. Arno and Fiedler do not only study areas where ponderosa pine or Douglas-fir are dominant or co-dominant. However, these two species dominated or co-dominated a large part of the montane zone. In addition, they are the most frequently mentioned species in Arno and Fiedler's work. So the comparison between the two scientific hypotheses is relevant (figure 2).

Figure 2. Past fire regimes (before 1900) within the montane zone

Low-severity regime			
	Fire interval	Role of fire and post-fire regeneration	Type of forest created
Arno and Fiedler	Low severity: 1 to 30 years	Fire spares large trees, eliminates and trims some saplings and branches, cleans the ground, facilitates growth	Open forest Abundant ponderosa pines, white pines (○), hemlocks, cedars (●); Douglas-firs (●) less abundant Widespread herbaceous species, flowers, small trees
Baker and colleagues	Low severity: perhaps 60-300 years	Burns surface fuels, kills or damages some canopy trees Limited regeneration because a part of the light is trapped by the understory and canopy	No notable difference compared with Arno and Fiedler apart from a more important heterogeneity of landscapes
Variable-severity regime (low, moderate and high)			
	Fire interval	Role of fire and post-fire regeneration	Type of forest created
Arno and Fiedler	Low severity: 1-30 years Moderate: 30-100 years High: 100-400 years	Fire of moderate severity eliminates most saplings, preserves a part of the oldest trees High-severity fire creates an heterogeneous forest See above about the role of low-severity fire	Open or partly open forest Well-spaced in height (various tree ages) Dominated by ponderosa pines, lodgepole pines (○), Douglas-firs, hemlocks, cedars (●)... Widespread herbaceous and shrub species
Baker and colleagues	Low severity: perhaps 60-300 years Moderate: perhaps more than 200 years High: perhaps 300-700 years	Ecological role of high-severity fire (usually during the summer or early fall) much more important than low-severity fire High-severity fire kills 70 percent of the trees or more* and is influenced by climatic conditions Fire stimulates tree regeneration and growth of shrubs Faster tree regeneration if post-fire decades moister than usual	Heterogeneity of landscapes alternately high or low due to: - climate variations - the variable severity of fire across time and space - natural thinning - insects and diseases that kill some high trees Dense stands alternate with heterogeneous or open stands (with older trees) After a severe fire, shrubs are more widespread than herbaceous species
<div>● shade-tolerant species</div> <div>○ shade-intolerant species</div>			
Sources: Arno et Fiedler, 2006; Baker et al., 2007; Baker, 2009; *Hessburg et al., 2007 Conception: Nicolas Barbier			

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Overall, Baker and his colleagues underscore the importance of the variability (from low to high) of landscape heterogeneity in most of the forested montane zone before 1900. They think that this distinctive feature is related to temporal and spatial fluctuations in disturbances (e.g., fire severity, climate, diseases, etc.). By contrast with Arno and Fiedler, Baker and his colleagues consider that the VSR affected a much greater area than the LSR. According to Baker, there are two main reasons for these differences in research conclusions: Baker's study areas are larger than those selected by Arno and Fiedler; they are also randomly selected unlike those chosen by Arno and Fiedler (Arno and Fiedler, 2005; Baker, 2009; Baker, 11/18/2013,

email). These three authors are also interested in the changes that have occurred in forest and fire management after 1900.

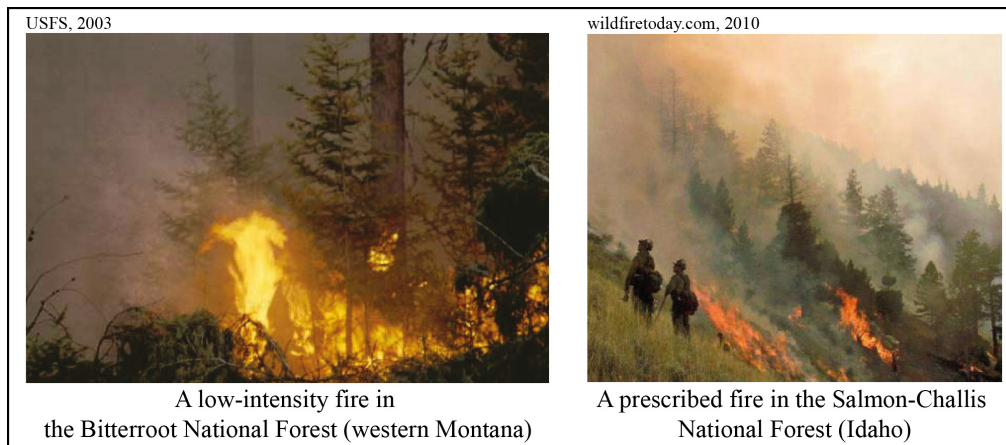
The transformative impact of forest and fire management since 1900

- 15 Researchers refer to the late 19th century or 1900 because human impacts (logging, road building, mining, grazing, fire management, etc.) altered immense forested areas afterwards. Extensive transformation started with intensive logging in the regional forests. In the late 19th century, loggers had already started cutting a part of the large old trees because of their commercial value. During the following decades in most national forests, they cut the bulk of the oldest fire-resistant coniferous trees. Their elimination left behind fuels (needles, branches, etc.) which increased the exposure to fire. In order to maximize logging, managers have often increased tree density.
- 16 Transformation has also resulted from the USFS's fire suppression or exclusion programs since the early 20th century. Habitually, these programs were designed to suppress all the fires that could be put out. Despite the inevitable progression of some uncontrollable fires, fire suppression has five common impacts: longer fire intervals have coincided with higher tree densities, fuel buildup (e.g., needles and other flammable debris), reduced tree regeneration and the building of a vast network of forest roads. Some impacts can be specified and nuanced. For instance, higher tree density and fuel buildup lead to a higher probability of high-intensity crown fires in areas that used to be subjected to the LSR (primarily) or VSR (more rarely) (Chmura et al., 2011). Moreover, extreme weather occurrences (severe drought and strong wind) are regularly the chief cause of high-severity fires, whereas fuel buildup due to fire suppression is commonly a secondary factor (Baker et al., 2007). Furthermore, this buildup following fire suppression does not apply to all fuels. Thus, large deadwood oft generated by fire may become scarcer due to fire suppression. In addition, fewer fires can reduce fuels such as shrubs and branches because fire often increases the resprouting and density of shrubs (McKenzie et al., 2004; Baker, 2009).
- 17 In the forests of Idaho and western Montana shaped by the VSR, logging combined with fire suppression have had other impacts. The increasing scarcity of fruit bearing shrubs and herbaceous species previously maintained by fires is one of them. In some areas, a higher density of Douglas-firs can be another impact (Arno and Fiedler, 2005), although this phenomenon can be caused by moderate-severity fires as well (Baker et al., 2007).
- 18 What lessons have contemporary managers of forests and fire learnt from these anthropogenic impacts?

Evolution of the management toward a partial ecological restoration

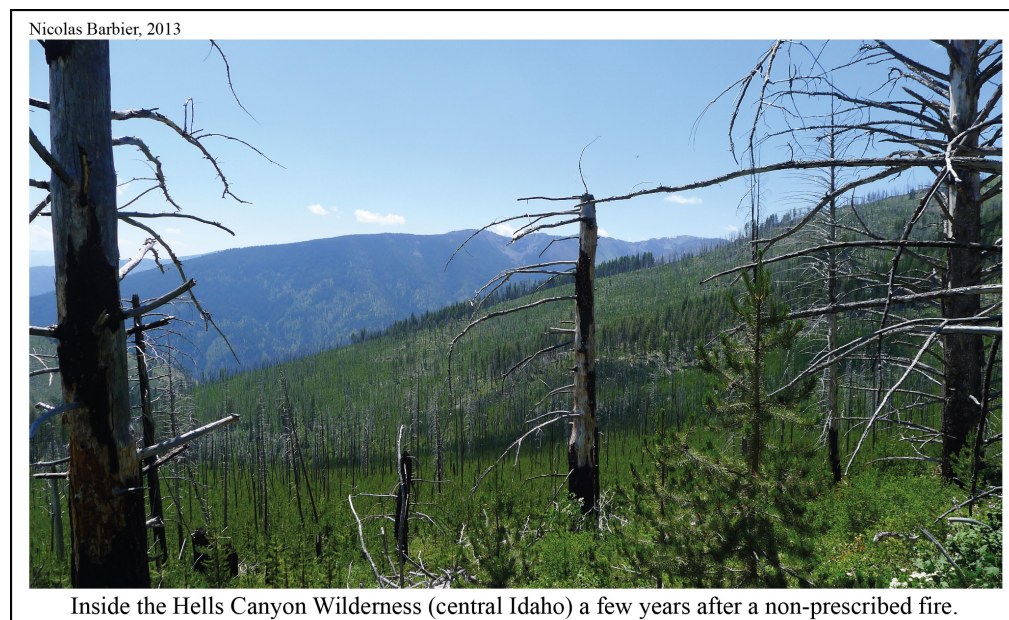
A compromise between productivity and ecological restoration?

- 19 During the 1970s, the use of fire changed in a part of the study area. Since then, federal fire managers have adopted a strategy that relies on three different methods. The latter aim at recreating swaths of forests in a state close to late 19th century's conditions.
- 20 Prescribed fires are one of these three methods. They are ignited by managers who control their movements and intensity (often low) (figure 3). A second method favors a hands-off approach: some non-prescribed fires are left as undisturbed as possible in isolated areas. The third method consists in thinning the undergrowth. Selection cutting¹⁰ and thinning are frequently combined for commercial purposes. In order to restore the desired forests, managers and scientists try to assess what the tree density, proportion of trees of various ages and sizes and species diversity were just before 1900 (Arno and Fiedler, 2005).
- 21 Since the 1990s, the USFS has been using an "ecological approach" to manage national forests. It contributed to reduce logging and had an impact on fire management. In some non-wilderness areas, the conservation or restoration of forest ecosystems have become a priority. On these lands, fire can be an essential management tool. However, in the context of global warming, the projects undertaken can only result in an incomplete and contingent restoration of past ecosystems and landscapes.

Figure 3. Prescribed fires

Science-based proposals for partial restoration through fire and related methods

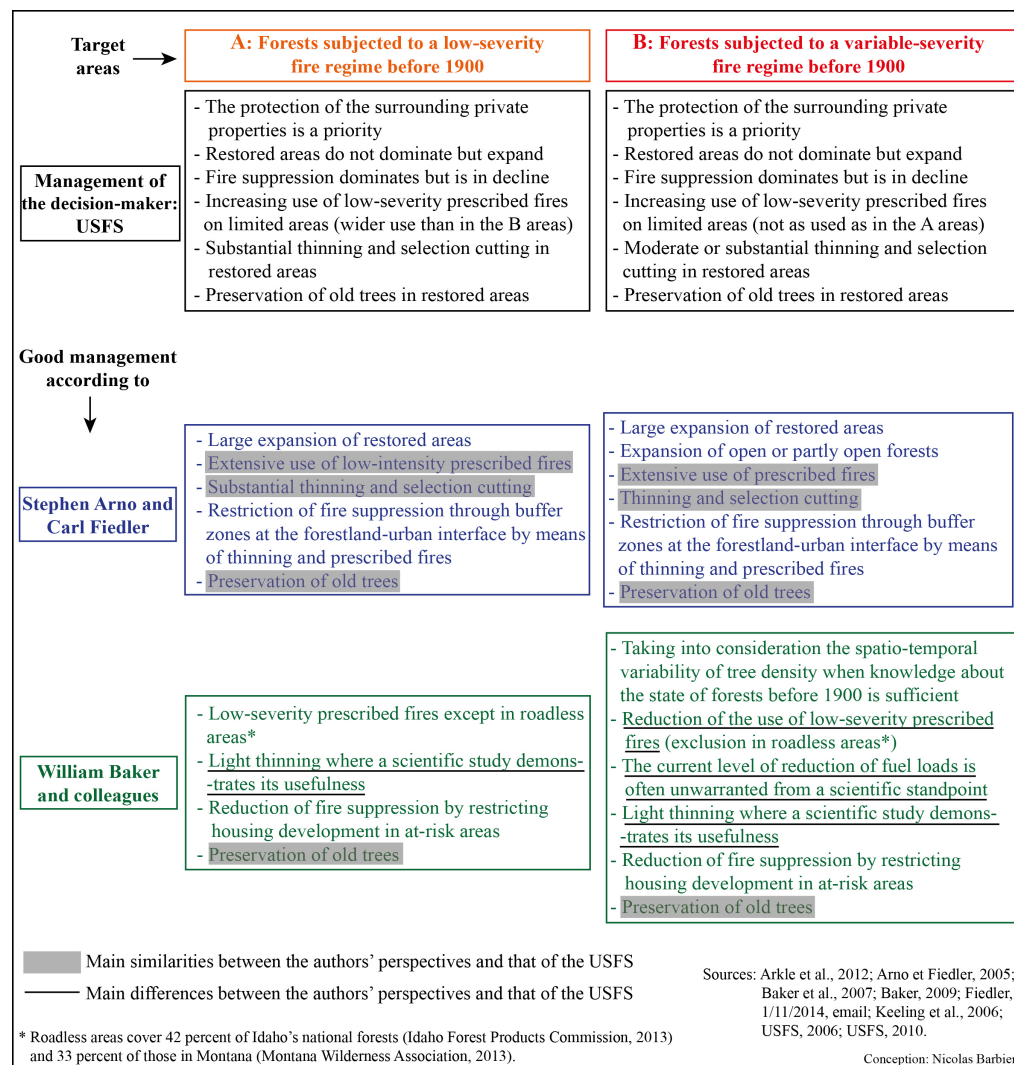
- 22 According to Arno and Fiedler, in the Inland Northwest, restored forests should include old, high and wide trees resistant to low- or moderate-intensity fires. This kind of forest helps the growth of vegetation made of abundant herbaceous species and berry bushes. They think that current forests are less resistant to fire than before 1900. They advocate the frequent use of low-intensity fires in order to get rid of excessive fuel loading. In their opinion, these prescribed fires combined with selection cutting should prevent the proliferation of coniferous trees like the Douglas-fir. They consider that a significant reduction of tree density can be appropriate in various areas. Today, USFS employees commonly reduce tree density (Arno and Fiedler, 2005).
- 23 According to Baker and his colleagues, the overall tree density before 1900 was higher than that estimated by Arno and Fiedler. They conclude that the reduction of tree density currently practiced by the USFS is excessive in a lot of areas. In most national forests subjected to the VSR in Idaho and western Montana, they stress the need for more research before acting. The goal of this research would be a more accurate knowledge of spatio-temporal variability in terms of tree density, average age of forests and fuel loads. In the rare stands where high and very old trees dominate, they recommend a light thinning treatment in order to help them spread. In old forests undisturbed by human activities (e.g., fragments of wilderness areas), they would let the natural fire regime and other ecological processes do their work (figure 4). In forests subjected to the LSR before 1900, they advise a restoration at the level of the stand. That would include thinning to clear the understory and a parsimonious use of prescribed fires. This work boosts the growth of ponderosa pines that, in turn, produce more seeds. It also helps the development of tree cavities that birds use as nesting sites. In order to be efficient, thinning and prescribed fires require reforms in logging and grazing as well as a control of invasive species where these phenomena damage the forests (Baker et al., 2007; Baker, 2009).
- 24 To what extent does the USFS take these scientific recommendations into consideration?

Figure 4. The impact of non-prescribed fire in a wilderness area

Synthetic analysis of the use of fire as management and restoration tool in non-wilderness national forests

- 25 The table below synthesizes three different perspectives (USFS; Arno and Fiedler; Baker and his colleagues) on the use of fire in ponderosa pine–Douglas-fir forests of the montane zone (figure 5).

Figure 5. The use of fire as management and restoration tool within non-wilderness national forests of the montane zone in Idaho and western Montana



26 In general in Idaho and western Montana, the USFS tends to favor the kind of restoration advised by Arno and Fiedler more than the recommendations made by Baker and his colleagues. As a consequence, prescribed fires and selection cutting are quite widely used. What are the results of these practices?

Restoration methods on the ground: a risky management?

Partial recovery of natural processes in wilderness areas

27 In portions of wilderness areas, fire management is characterized by the almost complete absence of human interference. This is due to a federal policy instated in the 1980s which values the ecological role of fire. In the middle of the following decade, the 1995 Federal Wildland Fire Management Policy specified management guidelines. In wilderness areas, although fire suppression has not been abandoned altogether, this policy has modified and minimized its use. One of the prime examples of its application lies within 1.6 million hectares concentrated in the Franck Church River of No Return (FCRNRW, central Idaho) and Selway-Bitterroot (SBW, central Idaho and western Montana) wilderness areas (plus a few contiguous and much smaller areas). Most regional wilderness areas are distant from major population centers. There, the USFS let most non-prescribed fires burn. However, when surrounding private properties (housing, infrastructure, equipment, livestock, etc.) are threatened by fire, firefighters respond to protect them and control the blaze. Between 1985 and 2000 within the FCRNRW, the impact of the federal fire policy was considerable: 46 percent of its area (about 428,000 hectares) was burnt during this period. This policy has contributed to restore forests

of the past. On some south-facing canyon slopes covered by ponderosa pines, the USFS has been trying to remedy what its managers view as a lack of low-intensity fires: on about 80,000 hectares of canyons within the Salmon valley of central Idaho, this federal agency launched a program of prescribed fires in order to reduce the fuel buildup. They are usually ignited in the spring and fall (Arno and Fiedler, 2005; Bunnell and Zimmerman, 2000).

These prescribed fires are also used in other federal lands where environmental protection is lesser than in wilderness areas.

The impact of prescribed fires and thinning in non-wilderness national forests

In the dry ponderosa pine forests of the montane zone, low-severity prescribed fires ignited during the spring and fall have a few serious impacts. They cause a decrease in the density of small trees while reducing fuel loads on both the ground and trees (but rarely in the canopy). They often abate the severity of subsequent non-prescribed fires, which lessens the risk of property damage. Prior thinning tends to make prescribed fires more efficient. The combination of thinning and prescribed fire can be renewed every decade in order to respond to plant regeneration and litter accumulation (Arkle et al., 2012).

The study of three examples in central Idaho gives a more detailed understanding of these impacts. In the fall of 2010 in the Nez Perce National Forest (NPNF), federal employees used prescribed fires on 1,800 hectares. Their goal was to reduce fuel loads and encourage the growth of herbaceous species that ungulates eat. The fires were preceded by logging on 28 hectares (USFS, 2010). According to the USFS, prescribed fires ignited in another fragment of the NPNF helped restore the forest and contain a non-prescribed fire that covered 10,000 hectares during the following summer (USFS, 2006). Prescribed fires are also used in the south fork Salmon river basin within the Payette National Forest (located south of the NPNF). Ranging in elevation from 1,100 to 2,500 meters, this basin was subjected to the VSR before 1900. Today, Douglas-firs dominate its north-facing slopes and ponderosa pines its south-facing slopes. Between May 2004 and 2006, three zones of less than 1,000 hectares each were treated with prescribed fires. Their severity was predominantly low, but it was higher on south-facing slopes where fuels were drier. Within these three areas, there were four reduction factors in the severity of the subsequent non-prescribed fires that occurred in 2007: this severity decreases as the severity of prescribed fires increases, the size of the treatment area gets bigger, the center of this treatment area gets closer and densely vegetated areas get farther away (Arkle et al., 2012).

If their local effects may be significant, the overall impacts of prescribed fires and thinning are limited by the continuation of fire suppression in most of the national forests studied.

Objectives and impacts of continuing fire suppression in national forests

Researchers assessed the impacts of fire suppression in seven areas of Idaho and Montana whose elevation ranges from 800 to 1,800 meters. These areas, co-dominated by ponderosa pines and Douglas-firs, had never been logged. Before 1900, they were subjected to the VSR. These researchers compared two different zone types within these areas: the least and the most exposed to fire. The first zone type is similar to fire exclusion zones: tree density is varying but generally much higher than in the second type while the understory has more plant species (Keeling et al., 2006).

In the national forest of Idaho and western Montana, the USFS continues to suppress most noteworthy fires. This policy is costly: from 2007 to 2012 in Idaho alone, between \$20 million and \$175 million were spent every year to suppress fires (USFS, 2013). Current legal norms favor fire suppression in vast expanses of national forests. It is about protecting private properties. The federal government does not want to be held accountable for the payment of private properties either damaged or destroyed by fires that started on federal lands. These fires result in additional substantial legal expenses for the government. So the USFS strives to minimize these compensation and justice expenditures. On the whole, they are higher than those of fire suppression. By and large, the federal protection of private properties restricts the

spread of non-prescribed fires. This being said, this restriction does not apply to wilderness areas and other federal lands where fire poses a very low or nonexistent hazard to private properties (USFS, 2009). Finally, a large portion of the American population is intolerant to smoke generated by wildfires (Arno and Fiedler, 2005). It creates health problems for some people. In fire prone populated areas, elected officials and managers take all these elements into consideration.

Desired forest conditions, not restoration?

- 34 Aside from criticism over prescribed fires in roadless areas and the amount of thinning, there is little scientific controversy about the current restoration of areas subjected to the LSR before 1900.
- 35 But when it comes to areas subjected to the VSR before 1900, it is a different story that should be discussed. In these areas, the USFS changes forests by using low-severity prescribed fires, selection cutting and a significant amount of thinning. By doing so, the agency takes risks in both scientific and ecological terms. These methods aim to shape broad swaths of open or partly open forests while producing timber and reducing both fuel loads and the impact of subsequent non-prescribed fires. Arno, Fiedler and the USFS argue that their research results warrant the widespread use of these methods. Arno and Fiedler even encourage the agency to increase their current use.
- 36 In a lot of targeted areas, William Baker and his colleagues think instead that more data need to be collected and analyzed before these methods can be extensively implemented. According to them, these additional data are necessary to adequately assess the past spatio-temporal variability in terms of tree density, average age of forests and fuel loads. This assessment would serve to determine the extent to which the above-mentioned methods can be used and refined. Are their recommendations excessively cautious?
- 37 If scientific knowledge is lacking, then the current national forest fire management is partly based on a weak scientific foundation on a vast scale. This does not mean, however, that the forests thus produced would be unsustainable. Over time, they may have conditions suitable for old trees, diverse wildlife habitats and a wide variety of herbaceous plant species.
- 38 In many cases, proponents of the existing fire management regime in national forests are unable to prove that the resulting forests will become as close as possible to those that existed before 1900. Yet this restoration is precisely one of the main goals of the current management of fire in national forests of the montane zone subjected to the VSR. As a consequence, the word “restoration” may be misleading. In fact, the USFS creates its desired forest conditions based on a combination of ecological and economic objectives, legal obligations and often incomplete scientific research.
- 39 In view of the current situation, fire managers and other stakeholders might want to think of alternative strategies. The latter could be implemented in the range of the VSR within the montane zone of Idaho and western Montana dominated by ponderosa pines and Douglas-firs. For instance, a different strategy could be applied in non-wilderness national forests in which there is very little or no risk that non-prescribed fires spread to the nearest inhabited zones and where the state of forests before 1900 is uncertain. In a sizeable portion of these areas, prescribed fires and substantial thinning could be prohibited. Near inhabited areas, along with existing measures, two tasks could be carried out. First, in a lot of cities and towns adjacent to national forests, there is a need for new zoning laws in order to minimize the loss of property due to fires. Second, on nearby national forest edges and when appropriate, edible bulbs and crops (camas, bitterroot, wild carrot, wild potato, etc.) could be planted as parts of buffer zones. Local Native Americans used to burn fields where these bulbs and crops grew in order to improve their yields.

Conclusion

- 40 At the end of the 19th century in Idaho and western Montana, the LSR created forests that were mostly open. Old and shade-intolerant trees like the ponderosa pine, herbaceous species and sun loving shrubs were abundant in these forests. Their appearance was sometimes homogeneous, sometimes partly heterogeneous.

- 41 Two scientific hypotheses distinguish themselves about the VSR and its impacts. This regime covered expanses of land that were much larger than the LSR. The first hypothesis is developed by Stephen Arno and Carl Fiedler and the second one is put forward by William Baker and his colleagues. According to these two hypotheses, the VSR shaped forests where shade-tolerant trees like the Douglas-fir were the most widespread. On south-facing slopes, tree density was usually lower than on north-facing slopes. The first scientific hypothesis stresses the open or partly open forests created by the VSR. The second one emphasizes the heterogeneity of landscapes that was alternately high or low due to the spatio-temporal variability of diverse disturbances (climate, fire severity, etc.). According to this second hypothesis, high-severity fires were rare, but their ecological role was much more significant than that of the more frequent low-severity fires.
- 42 Intensive logging in national forests from the late 19th century to the 1980s was combined with suppression of most fires. Suppression aims at protecting surrounding private properties. These two anthropogenic impacts transformed a part of the regional forests: some got denser, with more fuels and shade-tolerant species; old shade-intolerant trees got scarcer. Some specialists think that this type of predominant management is the main reason for a greater exposure of forests to high-severity fires. Others think that dry and windy conditions are a more defining factor. According to some of the most thorough research to date, in forests subjected to the VSR, the difference between the past (before 1900) and today are often light and sometimes unknown in terms of tree density, fire severity and fuel loads. Therefore, the current management is both sensitive and controversial. At the same time, solutions to reduce fire suppression (buffer zones at the forestland-urban interface; reduction of housing development in at-risk areas) are sporadically used by the USFS.
- 43 Initiated during the 1970s, the so-called restoration of past fire regimes and forests leans on two methods. The first method consists of prescribed fires, sometimes combined with thinning and selection cutting. Its goal is to reduce fuel loads and the severity of subsequent non-prescribed fires while preserving old trees. This method, geared towards specific desired forest conditions, is motivated by the USFS's ecological, economic and legal objectives. The problem is that it frequently lacks compelling scientific justification. The second method generally consists in minimizing or eliminating human intervention in wilderness and neighboring areas when non-prescribed fires do not threaten the surrounding private properties.
- 44 In the future, in part because of global warming, more properties may be destroyed by fires spreading from nearby national forests. Some uncertainties persist in relation to global warming. They are related to the variability of the climate system, changing greenhouse gas emissions or the use of different atmospheric general circulation models. Despite these uncertainties, almost all climate projections indicate that average temperatures in Idaho and western Montana will rise. This warming is projected to have serious consequences within the montane zone. These consequences should include a higher elevation of the transition between rain and snow during the cold season, declining winter snowpack, earlier snowmelt and more frequent rain-on-snow precipitation events. During the spring, more floods and increased runoff and soil erosion are projected. Warmer temperatures should also lead to drier summers, increased summer evapotranspiration, more severe droughts as well as reduced stream flows in the summer and early fall. Along with global warming, regional wildfires should become more severe, larger and frequent during longer fire seasons. These phenomena should increase the damages caused to trees and their mortality. They should reduce plant growth in forest ecosystems. In these conditions, fire-resistant species like the ponderosa pine and some mature Douglas-firs could spread. Others could get scarcer (Engelmann spruce) because of higher mortality and insufficient regeneration. In areas subjected to the LSR and VSR, landscapes should become homogenized: areas made of young trees should expand to the detriment of older stands; snags and woody debris on the ground could almost disappear. After several decades, the increasing fire frequency could result in the reduction of fuel loads, less severe fires and finer nuances in forest landscapes. In order to respond to global warming, the USFS intends to increase the use of thinning (while avoiding damages to trees and the soil) and prescribed fires (as a tool to reduce surface fuels loading and thin the forest). Post-fire

reforestation could include various methods such as assisted migration of species where they can adapt, transfer of seeds or changes in reproduction areas (Chmura et al., 2011).

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Notes

1 Ponderosa pines belong to shade-intolerant species. They grow well in sandy clay loam or gravelly sands (sometimes partially rocky). Some are more than 500 years old. This tree can grow in high elevation (up to 3,100 meters within its southern range) or at the sea level. It prefers well-drained soils and annual rainfall between 300 and 600 millimeters. It withstands both drought conditions and temperatures as low as -35°C. Because its bark is thick, it can resist low- to medium-intensity fires. Its seedlings can survive low-intensity fires (USDA, 2004 [b]).

2 The shade-tolerant Douglas-fir can grow up to 3,200 meters of elevation. It grows better on “clay loams, silty clay loams, and silt loams which are deep, moist, and well drained”. It needs more than 400 millimeters of annual rainfall and can withstand -33°C (USDA, 2004).

3 “Stand: an area within a forest that is relatively uniform in vegetation composition and structure and in environment” (Baker, 2009).

4 According to the 1964 Wilderness Act, wilderness areas must remain mostly undeveloped and unaltered by people in order to conserve their primeval characteristics. Their management must preserve or restore natural processes.

5 When I was a PhD student, I spent three full years at the geography department of the University of Idaho as a visiting scholar (contact: Gundars Rudzitis, geography professor: gundars@uidaho.edu). I defended my PhD dissertation on October 22, 2012. Its title is *Conflicts between Indians and Non-Indians over the management of land, the environment and natural resources in the Nez Perce aboriginal territory (Idaho, Oregon, Washington)*.

6 GEOLAB (UMR 6042), Université Blaise Pascal, Clermont-Ferrand (<http://geolab.univ-bpclermont.fr/spip.php?article220>).

7 Recent large fires may erase traces of older fires. They may prevent the reconstruction of a fire regime.

8 Stephen Arno is a retired research forester for the USFS. Carl Fiedler is a research professor of silviculture at the University of Montana.

9 William Baker (University of Wyoming), Rosemary Sherriff (Humboldt State University) and William Veblen (University of Colorado) are specialists of fire ecology.

10 Selective cutting takes out a relatively small proportion of commercially valuable trees that are carefully selected. Although it preserves most of the forest structure, selective cutting sometimes causes significant damages to ecosystems.

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Résumés

In Idaho and Montana just like in the rest of the U.S. Rocky Mountains, a part of the population wants to settle near forests perceived as environmental amenities. The regional net migration has been positive for about twenty-five years. Wildfires with variable intensity regularly destroy properties. Some of them kill people. Regionally, they are an important human, economic, political and environmental issue. Their significance is likely to increase due to global warming. A lot of these fires are ignited within the huge national forests of the montane zone (600 to 2,100 meters of elevation in the study area) dominated by Ponderosa pines and Douglas firs. Between the end of the conquest of the West and the 1970s, land uses have altered these forests and the fire regimes that affect them. For about four decades, managers have been involved in a partial and controversial restoration of pre-conquest fire regimes and forests they used to shape.

En Idaho et au Montana comme dans le reste des Montagnes Rocheuses états-uniennes, une partie de la population souhaite s'installer à proximité immédiate des aménités paysagères forestières. Le solde migratoire régional y est fortement positif depuis un quart de siècle. Des feux de végétation d'intensité variable y détruisent des propriétés à intervalles réguliers. Certains de ces feux sont meurtriers. Ils constituent un enjeu régional humain, économique, politique et environnemental dont la portée risque de s'accroître dans un contexte de réchauffement climatique. Bon nombre de ces feux démarrent dans les immenses forêts nationales de la zone montagnarde (600 à 2 100 mètres d'altitude dans la région étudiée) dominée par des pins Ponderosa et des sapins Douglas. Entre la fin de la conquête de l'Ouest et les années 1970, les impacts anthropiques ont fait évoluer ces forêts et les régimes de feux auxquels elles sont soumises. Depuis une quarantaine d'années, les gestionnaires ont amorcé une restauration partielle et controversée des régimes de feux d'autrefois et des espaces qu'ils contribuent à façonner.

Entrées d'index

Mots clés : feu de végétation, forêt nationale, gestion, Idaho, Montana

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